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In This Issue

U.S. farm production has now reached sufficient volume to require a major dependence on export markets. Future agricultural capability and the U.S. role in meeting world food needs have been subject to myriad assessments and reassessments in recent years. One popular scenario calls for both a growing dependence of American agriculture on foreign markets and a growing volatility in the level of these foreign demands for U.S. farm production. This scenario could lead to even more farm price volatility because when a competitive industry characterized by inelastic aggregate supply is subjected to volatile demands, prices will adjust more than will quantity. The articles and reviews in this issue examine five aspects of this scenario. They include a review of a conference on world food needs, a review of a study of grain production in a nation which is currently a major importer of agricultural commodities and which has the means to continue to import, a review of the efficacy of food aid in those countries which have the need but lack the means for food imports, a study of the performance of futures markets for commodities not heavily traded, and a simulation study of the viability of rice producers faced with increased price variability under alternative tenure arrangements.

In the first article, Gordon studies the extension of futures trading, an economic institution for dealing with price volatility, to thinly traded markets—that is, to commodity markets whose volume of trade places them at the margin of a viable market. Gordon examines the experience of the rough rice and milled rice futures market at the New Orleans Commodity Exchange and the sunflower futures market at the Minneapolis Grain Exchange. He concludes that during the time these markets were operating they retained some of those price and hedging characteristics of more heavily traded markets, but that their tendency to overreact to changes in supply and demand lowered their value to producers as indicators of future market conditions.

Grant, Richardson, Brorsen, and Rister follow with a study of the adjustment of the rice industry to increased price variability. They find that much of the burden of adjustment has fallen on rice producers. Increased price variability has significantly increased marketing margins on rice. The authors simulate the experience of rice farmers under alternative tenure arrangements. Under these conditions of increased marketing margins' lowering farm price and of more variable farm prices, the authors find that the probability that rice producers will remain solvent for a 10-year simulation period is much reduced.

In the Research Review section, Moore reviews ***Agriculture in the Twenty-First Century,*** the proceedings of a symposium on future world food needs that was generally optimistic about the world and particularly about U.S. ability to meet future food needs.

Cole reviews ***Prospects for Soviet Grain Production*** and discovers a historical treatment of Soviet agricultural problems rather than an explicit discussion of future Soviet grain production.

Shane reviews ***Closing the Cereals Gap with Trade and Food Aid,*** which finds an imbalance between those nations needing food aid and those receiving the aid.

Gerald Schluter

Contents

Performance of Thin Futures Markets: Rice and Sunflower Seed Futures

By Douglas Gordon*

Abstract

This article examines the performance of three thinly traded futures markets. It tests each market with several measures of efficiency and performance and compares the test results with those from a large and mature futures market. These thin markets possess some, but not all, of the attributes of an efficient futures market.

Keywords

Thin markets, futures markets, market efficiency

Introduction

Agricultural economists have long been interested in studying thin markets (*8*).[1] Their study, however, is often hampered by the very thinness they set out to analyze. An agricultural commodity futures market with low trading volume is a particularly good candidate for study. Much market information is reported on a futures market, even when trading volume is low. The information revealed by a thin futures market may tell us if such a market possesses any of the hedging or price forecast benefits of the more heavily traded ones. If thin markets have some, but not all, of these benefits, the data from a thin futures market may suggest which properties are lost and which remain.

Thinly traded markets are more susceptible to price manipulation than are heavily traded ones. A trade of relatively few contracts may move market price substantially. Prices on the futures market may not accurately reflect either price behavior in the cash market or expectations about the future. The information content of the futures price is a major benefit of futures markets. Inaccurate or biased prices may eliminate this advantage and may prevent farmers from choosing their optimum production plans.

Commodity futures markets trading recently with low volume include the rough rice and milled rice futures markets at the New Orleans Commodity Exchange (NOCE) and the sunflower futures market at the Minneapolis Grain Exchange (MGE).[2] Volume was often fewer than 1,000 contracts per month in each of these markets. The Commodity Futures Trading Commission (CFTC) designates markets with volume below this level as low-volume markets which may be subject to stricter reporting requirements than other futures markets.

Several characteristics are common to most successful futures markets:

> The terms of futures contracts are highly standardized with respect to quantity, grade, and location, time and method of delivery. The only matter to be decided at the time of transaction is price (*18*, p. 6).

*The author is an agricultural economist with the National Economics Division, ERS. He thanks Richard Heifner, Jitendar Mann, Allen Paul, Gerald Plato, and anonymous reviewers for helpful comments.

[1]Italicized numbers in parentheses refer to items in the References at the end of this article. I follow Hayenga and others who define a thinly traded market as one characterized by two criteria: "(1) fewness of negotiated trades in a specified market and time period, and (2) the level of market performance, especially its liquidity and corresponding price sensitivity to incremental buy and sell orders." Tomek has recently analyzed a thinly traded cash commodity market (*24*).

[2]Rough rice futures now trade on the floor of the MidAmerica Exchange. Milled rice and sunflower seed futures contracts are no longer traded.

The futures market in sunflower seed had most of these characteristics, but those in rice had fewer of them.[3]

Hedging Efficiency

In this section, I examine the efficiency of the futures price in relation to the cash market prices for rice and sunflower seed. This relationship shows the hedging efficiency (the efficiency of the markets for possible hedges by producers) of the markets. If the cash and futures markets behave efficiently, short hedging a crop will reduce a farmer's price risk rather than add to it (*9*, *10*).

Level of Activity in the Markets

Trading in milled rice, rough rice, and sunflower seed futures was generally low. Open interest in rice futures contracts never exceeded 10 percent of available stocks or 1 percent of annual production. Sunflower seed interest never exceeded 3 percent of production or 20 percent of domestic stocks. In contrast, the ratio of peak open interest in the September 1982 soybean contract was 29 percent of total stocks held on September 1, 1982, and the ratio in January 1982 (with much of the new crop in storage) was 12 percent.

Although there is no generally accepted lower limit to volume or open interest beyond which a market is deemed thin, the CFTC has defined low-volume contract markets as those where fewer than 1,000 contracts are traded in 4 of any 6 months. If contract volume falls below that level, the exchange must report more trading information to the CFTC to insure that there are no trade practice violations. Special reports are not required of new futures markets, such as those in sunflower seed and rough and milled rice, for 3 years after the CFTC approves the market. Exchanges whose contract markets fall below 1,000 contracts per month may ask the CFTC to waive the reporting requirement (*2*).

Some people believe more activity should be required to avoid the thin or low-volume designation. Silber suggested that a volume of 10,000 contracts traded per year in a commodity by the third year of its existence be the minimum below which a market is not successful (*22*). Successful markets such as soybeans on the Chicago Board of Trade and gold on the New York Commodity Exchange often trade more than 50,000 contracts per day.

One of the major reasons for buying or selling futures contracts is to hedge against price changes in the physical commodity. Farmers will sometimes short hedge their crop by selling the crop forward on the futures market. Processors will often long hedge by buying contracts for future delivery. In either case the futures market is used to insure against unanticipated price shifts for the physical commodity.[4]

The ability to hedge in a futures market depends on how closely the futures and the cash market prices are related. The delivery point basis, the difference between the futures price and the cash market price at a delivery point, should be predictable. In an ideal market, the basis would vary little day to day, with the cash price slowly rising toward the futures price over the crop year. The idealized trend in the basis reflects storage costs over the crop marketing year. The figure depicts the ideal cash-futures relationship.

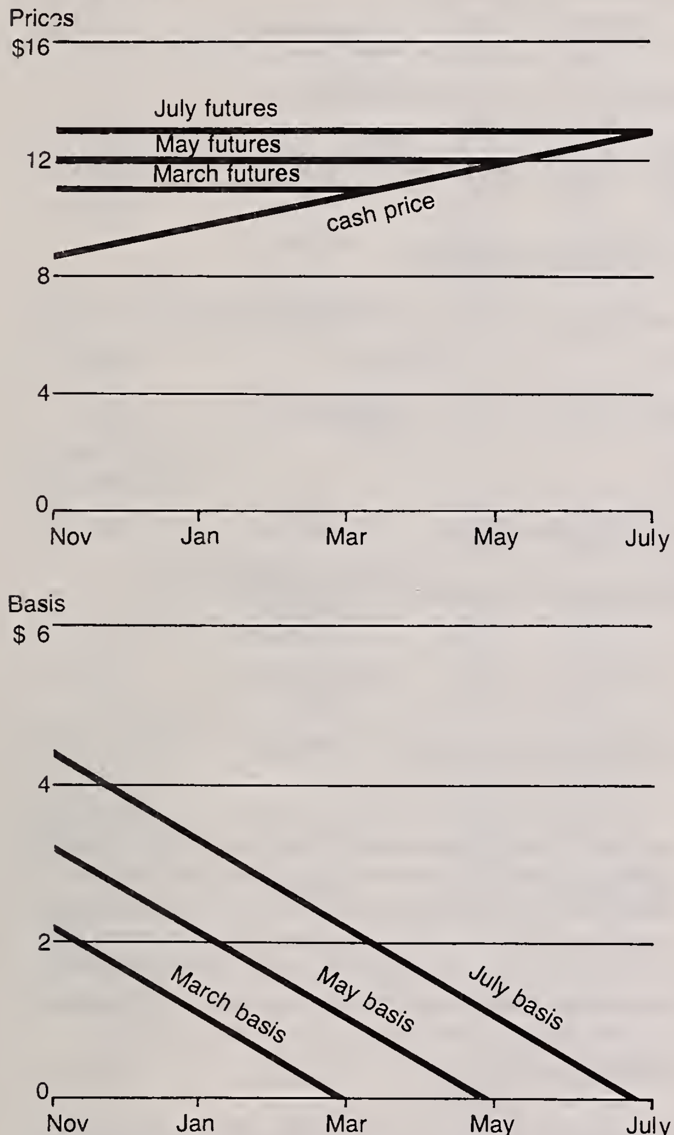
In the top diagram of the figure, the futures price appears as a horizontal line to make the relationship between cash and futures prices clear. In reality, both the cash and futures prices will change from day to day. Despite daily fluctuations, the basis (the relationship between the two) normally follows the trend shown in the diagrams.

Analyzing the futures-cash price relationship is difficult because daily cash prices in the rice markets

[3]The rice futures markets faced several obstacles to successful trading. First, rice is not so uniform a commodity as most others traded on futures exchanges. There are several varieties of rice and several grades of each variety. Second, milling yields vary substantially from one farm to another and from one year to the next. Third, reported cash market prices are less specific than those for other commodities. There is no daily or weekly rough rice cash market price for a specific variety and grade. Weekly cash market prices are reported for milled rice, but they are often expressed as a range; for example, $16-18 per hundredweight (cwt). This range may not vary for several weeks, or it may be occasionally reported as a single price—for example, $18 per cwt. Fourth, rice futures markets are new and were the first futures to be traded on the NOCE. Few new futures markets become successful. For example, milled rice futures were traded on the New York Mercantile Exchange for a short time in 1964. Fewer than 50 contracts were sold, and the market closed after a few months. Each of these factors may have hindered growth in volume and open interest in rice futures.

[4]A short hedge is the sale of contracts on the futures market by those who plan to sell the physical commodity in the future (for example, a soybean farmer) to insure against a fall in the price of the commodity. A long hedge is the purchase of futures contracts by those who plan to purchase the physical commodity in the future to insure against a price increase.

Idealized Behavior of Futures Prices, Cash Prices, and the Basis



Source: (19, p. 49).

are lacking. The U.S. Department of Agriculture (USDA) quotes cash prices for milled rice in Arkansas and Louisiana 1 day a week. The weekly price is usually a range of prices rather than a single price for a specific quality and type of milled rice. Because there are no published cash market prices for a specific deliverable variety and grade of rough rice, basis analysis of that market is impossible. To analyze the milled rice basis, one must compare the Monday closing futures price with the midpoint of the range of Monday prices reported for the Louisiana and Arkansas cash markets. Thus, the basis analysis can be only a rough estimate of the behavior of the milled rice basis, rather than a precise calculation.

USDA quotes sunflower seed cash market prices daily at Minneapolis and Duluth. Duluth was the par delivery point for sunflower seed futures. Sunflower seed could be delivered at Minneapolis at a discount.

Correlation between Cash Market and Futures Prices

Table 1 shows the correlation between changes (first differences) in cash market price and futures price for milled rice, sunflower seed, and soybeans. Daily price changes are shown for sunflower seed and soybeans, and weekly price changes are shown for milled rice. The correlation between actual cash and futures price will be much higher than the correlation between the first differences of the price series. The correlation between the first differences does show how closely the series move together, which is important to hedgers. Correlation between cash and futures price changes will be highest at the par delivery points. Other cash markets will have transportation costs and local cost factors which reduce the correlation with the futures price changes.

The soybean cash-futures correlation is higher than that for milled rice or sunflower seed. The milled rice correlation coefficients are quite low, partly because of the lack of a cash market price at a single delivery point. The correlation between changes in the milled rice futures price and those in the Arkansas price were much higher in the second year of the futures market than in the first. This disparity suggests that hedgers were better able to avoid basis risk, the random variation in the basis. The correlation between changes in the Duluth cash market price for sunflower seed and those in the futures price fell from 0.529 in the first year to 0.302 in the second year of the futures market. This decrease suggests an increase in basis risk and a deterioration in the ability of farmers to hedge sunflowers.

In a normal or carrying-cost market, the cash price at the delivery point will typically be below the futures price for delivery during the crop marketing year. This premium of futures over cash gives a return to storing the grain over that period. Away from the par delivery points, the cash price may exceed the futures price by the transportation cost.

Table 1—Correlation between first differences of cash and futures prices[1]

	Milled rice (weekly price changes)			
	January 1982 contract		January 1983 contract	
	Louisiana	Arkansas	Louisiana	Arkansas
Futures	0.038 (.817)	0.104 (.523)	0.052 (.757)	0.293 (.074)
Louisiana		.366 (.019)		.150 (.299)
	Sunflower seed (daily price changes)			
	May 1981 contract		March 1982 contract	
	Minneapolis	Duluth	Minneapolis	Duluth
Futures	0.261 (0)	0.529 (0)	0.206 (.002)	0.302 (0)
Minneapolis		.445 (0)		.383 (0)
	Soybeans (daily price changes)			
	November 1981 contract		November 1982 contract	
	Chicago		Chicago	
Futures	0.670 (0)		0.705 (0)	

[1]The probability that the null hypothesis (H_0: correlation = 0) contains the estimate is in parentheses.

Subtracting the transportation cost from the cash price would yield a graph similar to that in the figure. The cash price at harvest is typically the lowest price of the crop year, with price rising relative to the futures price by the approximate cost of storage each month after that. The cash price also typically drops sharply as the new crop is harvested. There are no returns to storage in this period. Yet, the cash price and the November futures price should converge (the basis approaches 0 or a fixed transportation cost) as the date of contract maturity approaches. See Kahl's studies of the corn basis from 1960-75 for a detailed analysis of longrun basis behavior (*11, 12*).

Basis Regressions

Table 2 displays regressions of basis against time. If prices behave as expected, the basis (futures minus cash) will fall during the crop marketing year as the contract nears maturity, reflecting carrying costs for the cash commodity. The daily basis was regressed on time for sunflower seed and soybeans. The weekly basis each Monday was regressed against time for milled rice. I used only one contract late in the crop year to represent each crop year. Because the data for each contract overlap with data for other contracts within the same marketing year, regressions on several contracts within a year would not be independent.

The rice basis over the May 1981 contract behaved as expected. The trend in the basis was downward and significant. The trend in the May 1982 contract was significant, but in the wrong direction. Cash began above the futures price in that crop marketing year and fell towards the futures price. The January 1983 contract once again showed a falling and significant trend in the basis.

In the July 1980 and March 1982 sunflower seed futures contracts, the trend in basis was insignificant or significant in the wrong direction, after corrections for autocorrelation in the errors. Only the July

Table 2—Basis regressions[1]

Milled rice					
May 1981	Arkansas	= 1.43 − 0.62 Time (3.38) (−5.65)	R^2 = 0.889	Rho = −0.20 (−0.53)	DFE = 4
	Louisiana	= 0.28 − 0.38 Time (0.45) (−2.35)	R^2 = 0.581	Rho = −0.23 (−0.62)	DFE = 4
May 1982	Arkansas	= −3.88 + 0.09 Time (−10.74) (5.88)	R^2 = 0.455	Rho = 0.64 (4.82)	DFE = 31
	Louisiana	= −3.84 + 0.09 Time (−11.22) (5.19)	R^2 = 0.464	Rho = 0.63 (4.68)	DFE = 31
January 1983	Arkansas	= −0.08 − 0.17 Time (−0.41) (−6.65)	R^2 = 0.815	Rho = 0.09 (0.34)	DFE = 10
	Louisiana	= −0.71 − 0.12 Time (−2.19) (−2.94)	R^2 = 0.464	Rho = 0.47 (1.90)	DFE = 10
Sunflower seed					
July 1980	Minneapolis	= 0.41 + 0.012 Time (1.57) (1.43)	R^2 = 0.043	Rho = 0.793 (9.11)	DFE = 46
	Duluth	= 0.37 − 0.001 Time (5.55) (−0.65)	R^2 = 0.008	Rho = 0.376 (2.93)	DFE = 49
July 1981	Minneapolis	= 4.48 − 0.020 Time (20.2) (−15.2)	R^2 = 0.649	Rho = 0.755 (13.0)	DFE = 125
	Duluth	= 4.61 − 0.022 Time (22.2) (−15.8)	R^2 = 0.682	Rho = 0.661 (9.61)	DFE = 116
March 1982	Minneapolis	= 0.34 + 0 Time (3.91) (0)	R^2 = 0	Rho = 0.688 (7.40)	DFE = 58
	Duluth	= 0.30 − 0.001 Time (5.43) (−0.85)	R^2 = 0.014	Rho = 0.564 (5.06)	DFE = 52
Soybeans					
July 1980	Chicago	= 1.609 − 0.00519 Time (20.1) (−14.0)	R^2 = 0.882	Rho = 0.743 (13.9)	DFE = 155
July 1981	Chicago	= 2.125 − 0.00759 Time (30.2) (−23.5)	R^2 = 0.782	Rho = 0.684 (11.8)	DFE = 154
March 1982	Chicago	= 0.243 − 0.00258 Time (7.70) (−3.61)	R^2 = 0.159	Rho = 0.751 (9.65)	DFE = 69

[1] Arkansas = Monday milled rice futures closing price minus Arkansas Monday cash price. Louisiana = Monday milled rice futures closing price minus Louisiana Monday cash price. Minneapolis = daily closing sunflower futures price minus daily Minneapolis cash price. Duluth = daily closing sunflower futures price minus daily Duluth cash price. Chicago = daily closing soybean futures price minus daily Chicago cash price.

Time takes the value 1 for the first observation, 2 for the next, and so forth.

Rho is the estimated first-order serial correlation, calculated as $u_t = ru_{t-1} + e_t$, where u_t are the OLS residuals and e_t is a random error.

DFE are the degrees of freedom of the estimate.

The first milled rice contract uses data from the start of futures trading until the expiration of the May 1981 contract. The last two milled rice regressions use data from October 1 until the expiration of the specified contract.

The sunflower seed and soybean regressions use data from December 1 until the expiration of the specified contract, except in the July 1980 sunflower seed contract, where data begin with the start of futures trading in the market; t-statistics are in parentheses.

1981 contract basis showed the trend typical of more heavily traded futures markets. The soybean basis, by comparison, had a significant and declining trend in each contract tested.

These results suggest that farmers' ability to hedge in the milled rice and sunflower futures markets was quite limited. The basis tended to move the wrong direction on hedgers in one of the three milled rice contracts and had no significant trend in two of the three sunflower seed contracts.

Because cash price was significantly higher than futures price in the early milled rice contracts, hedgers might have been persuaded that transportation and other costs justified a large premium for the cash market. They would expect the cash price to continue to rise farther above the futures price (the basis becoming more negative), reflecting the costs of carrying stocks of rice over the period. When the cash price fell toward the futures price, hedgers may have been caught by surprise. In later contracts, the basis was closer to normal behavior. The basis itself was closer to zero, and the trend of cash price rose relative to futures price over the crop year.

Basis variability seems to be a substantial problem in the rough rice futures market as well. Because there is no appropriate cash market price for rough rice, analyzing hedging potential was impossible. The rough-rice contract allowed par delivery at several points in Arkansas, Louisiana, Mississippi, and Texas. The price differentials between delivery points were unable to accommodate this variability. In late 1982, the New Orleans Commodity Exchange proposed that par delivery be restricted within a 10-mile radius of Greenville, MS. Those planning or accepting delivery would then be certain of the delivery location. A single delivery point might have reduced the variability between the futures and cash prices as well as have eliminated the variability in price between delivery points (*3*, p. 3400).

Deliveries on Contracts

Most futures markets have a relatively low percentage of deliveries, with an average of less than 2 percent of total volume (*23*, p. 24). The milled rice market exceeded this percentage in seven of the nine contracts. Although the percentage of deliveries on the rough rice market was generally lower than that on the milled rice market, it was also above 2 percent of all volume in a majority of contract months. In May 1982, both the rough and milled rice futures markets had unusually large deliveries. Milled rice showed a higher percentage of deliveries on contracts. Sunflower seeds had relatively large deliveries on each contract. Deliveries in May 1981 were a much higher percentage of peak open interest than earlier. Open interest was very low in the last two contracts; therefore, the ratios provide less information for these contracts.

Table 3 presents the peak open interest for each contract maturity traded and the number of contracts delivered on the futures markets as a percentage of peak open interest. This fraction is higher than the ratio of deliveries to total volume. Unusually large deliveries on a contract show up more clearly when the ratio of deliveries to peak open interest is used than when the deliveries to volume ratio is given. This ratio shows when specific contracts have far more deliveries than do other contracts for a given commodity. The percentage of deliveries is quite high in some contract maturity months.

If an unusually large number of deliveries are made on a contract, speculators may tend to avoid that market. A high ratio of deliveries to open contracts suggests an inefficient pricing mechanism. It is generally far less efficient to deliver on a futures contract than to simply offset one's position in the futures market and deliver at a local cash market:

> Making delivery on the futures contracts is seldom the most efficient way out of a hedge, particularly for the farmer, Paul says. He notes that futures markets are designed to transfer risks, not products.
>
> The contracts provide for delivery so that cash and futures prices will be linked together. Normally, just the threat of delivery is enough to accomplish that goal. Deliveries against agricultural futures contracts usually amount to less than 5 percent of the average number of open positions reported (contracts that have been entered into and not quickly offset) (*17*, p. 12).

The high percentage of deliveries in the early contracts of the rough rice futures market is probably due to the problems in starting a new futures

Table 3—Ratio of deliveries on contracts to peak open interest[1]

Contract maturity month	Sunflower seed		Rough rice		Milled rice	
	Ratio	Peak open interest	Ratio	Peak open interest	Ratio	Peak open interest
	Percent	*Contracts*	*Percent*	*Contracts*	*Percent*	*Contracts*
July 80	18	304	—	—	—	—
Nov. 80	19	1,259	—	—	—	—
Jan. 81	27	570	—	—	—	—
Mar. 81	34	570	—	—	—	—
May 81	67	1,308	67	24	6	88
July 81	50	698	49	66	—	—
Sept. 81	—	—	15	694	28	253
Nov. 81	4	211	32	716	17	449
Jan. 82	13	15	28	374	38	294
Mar. 82	59	32	10	410	34	193
May 82	—	—	86	336	84	169
July 82	—	—	19	364	—	—
Sept. 82	—	—	18	764	45	461
Nov. 82	—	—	13	874	43	221
Jan. 83	—	—	44	476	18	233

— = No contracts traded.
[1]Ratio is the ratio of deliveries to peak open interest. Delivery and open interest data were obtained from the Commodity Futures Trading Commission and from exchange publications.

market. The high percentage of deliveries in some later months, particularly in the milled rice market, suggests that the market was too thinly traded to provide an efficient market for hedgers and speculators. Short hedgers holding rice or long hedgers wanting rice may deliver or take delivery on the futures market rather than subject themselves to the price necessary to cancel their futures position. Volume and open interest figures show that trading in the milled rice market fell off after the September 1982 contract, perhaps as a result of the unusual price and delivery behavior in that contract month. A similar problem probably occurred in the May 1981 sunflower seed contract, when open interest in sunflower seed fell sharply after the contract matured.

Pricing Efficiency

Participants in a futures market are much concerned with how well futures prices reflect expectations of future market conditions. There is a large and rapidly growing literature on the nature of the futures price/expectations relationship. The efficient market hypothesis, summarized by Fama, states that an efficient futures market should reflect all information about expected supply and demand (*5*). Such a market should provide an unbiased and efficient (relative to other forecasting techniques) estimate of the actual price at contract maturity. Fama gave three degrees of market efficiency and the information needed to test a market for each one:

> Strong-form tests are concerned with whether individual investors or groups have monopolistic access to any information relevant for price formation.... In the less restrictive semi-strong form tests, the information subset of interest includes all obviously publicly-available information, while in the weak form tests, the information subset is just historical price or return sequences (*5*, p. 370).

The limited history of futures prices in the rice and sunflower seed futures markets considerably narrows the variety of tests that may be applied. We can apply several weak form tests, however, which should help answer two efficiency questions: Are the futures prices on thinly traded markets efficient ones? Are they reliable estimates of future conditions in the market?

If so, the value of these markets to agriculture is much greater than their hedging value alone. If not, farmers may be misled by the posted prices.

Measures of Randomness

One important criterion for the efficiency of a series of day-to-day price changes is that the series be serially uncorrelated. If price changes are significantly related in some fashion, the market is inefficient.[5] For example, if one discovers that price changes in a market are significantly related by some means and if entry into the market is easy, then there is nothing to prevent that person from using a system based on that knowledge to buy and sell enough contracts to make a personal fortune at the expense of the other market participants. Such a market would clearly be inefficient, as there is a disparity of information about the appropriate market price. In an efficient futures market, arbitragers would prevent the price from moving very far from one which represents the underlying supply-demand equilibrium.

Under the hypothesis of market efficiency, futures prices should follow a martingale, or more generally, a submartingale process. This hypothesis means that the price of the commodity on day t + 1 should depend only on the price on day t plus a random quantity, not on the entire history of prices. Thus, if we denote the price of rice futures contracts on day t calling for delivery in month i by $F_{i,t}$ and the price for the same futures contract on the following day as $F_{i,t+1}$, then price changes following a martingale process should be serially uncorrelated and the price series should exhibit the following property (*6*, p. 209):

$$E_t(F_{i,t+1}|F_{i,t},F_{i,t-1},F_{i,t-2},\ldots) = E_t(F_{i,t+1}|F_{i,t}) = F_{i,t} \quad (1)$$

In a submartingale, the equality would be replaced by $\geq$. This generalization allows an upward drift in the series. That is, prices may have an underlying tendency to rise, because of inflation. A submartingale process could still describe the series of price changes in this case.

[5]Danthine shows that this need not be the case in cash commodity markets (*4*). A cash commodity market may operate efficiently, yet barriers to entry, economies of size, and risk aversion can cause prices to follow an identifiable process. An efficiently performing futures market avoids these problems. The cost to enter or exit the market is quite low (the commission charge) so that a futures market can more closely approximate a perfectly competitive market. In fact, one would expect price changes in the cash markets for a commodity which also trades on the futures market to be less predictable than in cash markets for commodities without futures trading because some potential profit schemes based on price-determined trading rules would be arbitraged away.

A strong requirement for efficiency is often given, that of a random walk. For prices to follow a strict random walk, equation (1) must hold, the price changes must be independent, and the higher moments of the distribution of price changes must be constant. Thus, a distribution of price changes with variance increasing over the life of the contract would not be consistent with the simple version of the random walk hypothesis.

The distribution of price changes in agricultural commodities may have nonconstant variance because of seasonality in the amount of information affecting the market. That is, price changes may be more variable in the summer when day-to-day changes in the weather can affect expected crop size dramatically than in the winter when changes in expectations are fewer. Samuelson has shown how variance should tend to increase over the life of a futures contract (*20*, *21*). Anderson presents evidence that seasonality in the size of the variance is typical of agricultural commodity futures markets (*1*).

There are several ways to test the randomness of a series. Mann and Heifner (*15*, p. 13) describe the turning point test, a nonparametric test for serial dependence developed by Kendall and Stuart (*13*):

> Kendall and Stuart (Vol. III, pp. 351-53) show that the expected number of turning points in a random series of length n is:
>
> $$E(p) = \frac{2}{3}(n - 2)$$
>
> and the variance of the number of turning points is:
>
> $$Var(p) = \frac{16n - 29}{90}$$

The turning point test examines the number of times a move upward (or downward) is reversed and compares that number with a theoretically calculated value. A series where each price was above the previous one would have no turning points and would thus fail this test for randomness. This test is a rather weak one against an underlying trend:

> This is intuitively reasonable, for 'turning' is a local property and would not be much

affected by whereabouts along a line of gentle trend development the series had arrived (*13*, p. 355).

The test is much stronger against cyclical behavior and runs up and down in price. These aspects make it quite useful in testing the submartingale hypothesis.

The difference sign test, a test of the number of day-to-day moves in one direction, provides a simple test for trend (*13*, p. 355). If the number of daily upward moves is substantially greater than the number of downward moves, the series has a significant trend. A significant trend would reject the strict random walk hypothesis, but would not by itself reject efficiency under the more general efficient market hypothesis that price changes follow a submartingale.

Tests of Randomness for the Futures Markets

I tested the randomness of the percentage closing price changes in the rough rice, milled rice, and sunflower seed futures markets with the turning point test to see if these markets were economically efficient. Table 4 contains the calculated test statistics. The turning point test shows that the null hypothesis of randomness could not be rejected in most contract months for each of the futures markets. Table 4 also includes turning point test results for changes in the soybean closing price. These data enable one to compare results with those from a larger and long-established market. The efficiency hypothesis of randomness could not be rejected at a 95-percent confidence level for any of the soybean contract months. This comparison shows that the turning point test was not so sensitive that it would reject efficiency for a heavily traded and presumably efficient futures market. Randomness was not rejected for closing prices in the milled rice market for any contracts. Closing price changes in the rough rice contracts for May 1981 and May 1982 were nonrandom. In the sunflower seed market, only the last contract, March 1982, showed significant nonrandomness.

On many days there were no trades in a particular contract month on the rice and sunflower futures markets. Even if there was no trading, a settlement price was established to mark the contracts to market. The daily closing price might not represent the actual trading results in this case because some

Table 4—Turning point test of randomness[1]

Contract month	Sunflower seed		Rough rice		Milled rice		Soybeans
	Close	Open	Close	Open	Close	Open	Close
July 80	– 1.53	– .56	—	—	—	—	1.29
Nov. 80	– .34	– .54	—	—	—	—	.74
Jan. 81	– 1.09	1.45	—	—	—	—	.98
Mar. 81	.54	.81	—	—	—	—	.41
May 81	– .34	– .51	– 2.73*	– 1.66	0.33	0	.11
July 81	0	– .71	– 1.83	– 1.39	—	—	0
Sept. 81	—	—	.68	.53	– 1.43	.47	.37
Nov. 81	– 1.82	– 1.29	– 1.79	– .97	– .64	– .13	.58
Jan. 82	1.78	0	– 1.44	.24	– 1.71	.77	.94
Mar. 82	2.05*	0	– 1.82	.66	– .68	.85	– .35
May 82	—	—	– 3.10*	– .44	– .78	– 1.15	.36
July 82	—	—	– .28	– .78	—	—	– .97
Sept. 82	—	—	.18	.61	– .78	– 2.71*	.38
Nov. 82	—	—	– 1.41	– 3.10*	– .41	1.26	– .73
Jan. 83	—	—	– 1.39	.25	– .71	– .08	ND

ND = No data.
— = No contracts traded.
[1]The turning point test statistic is compared with the 95-percent confidence interval value of the t-distribution. For all but the May 1981 rice contracts, the value of the 95-percent level is approximately 1.98. For the May 1981 contracts, it ranges from 2.0 to 2.2 depending on the number of days when that price was recorded. For all closing prices in sunflower seed futures, the value at the 95-percent level is between 1.98 and 2.0.
*shows that randomness was rejected at the 95-percent confidence level for that contract.

days had no buyers or sellers at the given settlement price. As an alternative one may look at the open, high, low, or mean of high and low prices on the days when there was trading. These prices were not reported if no trades occurred. Of these, the opening price is the most satisfactory for the markets. At first glance the mean might seem preferable, but distributions of changes in means of daily prices have been found to be autocorrelated. This appears to be the case even with the means of daily high and low prices (see *26*).

Because closing prices were often nominal (that is, no trading occurred on those days), the opening prices were also tested. The September 1982 milled rice contract failed the randomness test in opening price. There was also a large number of deliveries in this contract although not as many as in the May 1982 contract. Percentage changes in rough rice opening prices were nonrandom in the November 1982 contract. All the sunflower contracts appear to be random in changes in opening price. Again, efficiency could not be rejected for any soybean contracts.

The turning point test results suggest that, despite the thinness of trading in these markets, randomness in price changes was maintained. A system could not be devised to take advantage of the history of the futures price changes to predict the future better than the forecast of the current futures price.

Trend

Commodity prices gradually trended downward over much of the period studied. The difference sign test shows whether there was a significant trend in the price changes. This test was performed on each rough rice, milled rice, and sunflower seed contract for both closing and opening prices. Soybeans were tested for comparison (see table 5).

Several contracts showed a significant trend in closing price changes for rough rice. Opening price changes showed a trend in two cases. The milled rice contracts showed fewer cases of trend, one in closing price changes and one in opening price changes. The November 1981 contract in sunflower seed had a significant trend in opening price changes, whereas the May 1981 contract showed trend in closing price changes. The test results for soybean closes showed no significant trend, but opening price changes showed a significant trend in several contracts.

The existence of a trend in several contracts does not reject the general market efficiency hypothesis, as the existence of a trend in price changes is not in-

Table 5—Difference-sign test[1]

Contract month	Sunflower seed		Rough rice		Milled rice		Soybeans
	Close	Open	Close	Open	Close	Open	Close
July 80	–1.00	–1.25	—	—	—	—	1.43
Nov. 80	–1.21	–.60	—	—	—	—	–.10
Jan. 81	–1.74	–1.11	—	—	—	—	.61
Mar. 81	–.12	–.13	—	—	—	—	–.92
May 81	–2.18*	.69	–.50	0	1.00	–0.35	–.20
July 81	–.57	–1.59	–2.12*	–.58	—	—	–.10
Sept. 81	—	—	–.83	–2.00	.35	–3.67*	–.43
Nov. 81	–1.82	–2.45*	–1.16	–1.16	–.87	–1.73	.92
Jan. 82	1.78	–1.25	–1.55	–3.10*	–1.03	–.50	1.43
Mar. 82	2.05	.87	–2.30*	–2.52*	–.38	–.34	–.82
May 82	—	—	–1.21	–3.67*	–1.75	0	.41
July 82	—	—	–.43	–.75	—	—	.20
Sept. 82	—	—	–1.66	–1.25	–2.67*	–.69	–.21
Nov. 82	—	—	–1.44	–.78	1.02	–1.36	–.50
Jan. 83	—	—	.28	–1.33	.38	–.14	ND

— = No contracts traded.
*marks values significant at 95-percent or greater confidence level.
ND = No data.
[1]The numbers displayed are the t-values.

compatible with a submartingale or supermartingale process. The strict random walk hypothesis, which does not allow for a trend in the price changes, would be rejected with these data.

A Test for Autocorrelation among the Futures Prices

If one can identify an autoregressive process in the futures market, one can use that information to profit at the expense of other market participants. By definition, an efficient market does not allow guaranteed profit of that nature. Estimates of autocorrelation parameters need not yield results identical to other tests of randomness as autocorrelation estimates involve the size of the day-to-day change in price as well as its sign. Autocorrelation estimates are also parametric; that is, they rely on assumptions about the underlying distribution of price changes. Autoregressive components were estimated for the price changes of rough rice, milled rice, and sunflower seed futures (see tables 6 and 7). The rough rice and milled rice markets both showed significant autocorrelation in the percentage changes in closing price for several contract months. Autocorrelated futures

Table 6—Autoregressive parameter estimates: Milled rice and rough rice[1]

Contract maturity	Closing price				Opening price			
	Milled rice		Rough rice		Milled rice		Rough rice	
	First order	Second order	First order	Second order	First order	Second order	First order	Second order
May 1981	0.463* (2.41)	– 0.080 (– .42)	0.343 (1.86)	– 0.101 (– .55)	0.186 (.90)	0.243 (1.18)	0.041 (.15)	– 0.058 (– .21)
July 1981	—	—	.230 (1.93)	.122 (1.02)	—	—	.279 (1.65)	– .161 (– .95)
Sept. 1981	.198* (2.11)	.003 (.03)	.070 (.75)	.093 (1.0)	– .010 (– .11)	.158 (1.64)	.047 (.50)	– .010 (– .10)
Nov. 1981	.003 (.03)	– .073 (– .91)	.135 (1.68)	– .041 (– .50)	.067 (0.83)	– .006 (– .08)	.053 (.65)	– .029 (– .36)
Jan. 1982	0.144* (2.03)	– .043 (– .66)	.183* (2.61)	– .034 (– .49)	.003 (.03)	– .065 (– .87)	.045 (.61)	– .006 (– .08)
Mar. 1982	.135* (2.03)	.021 (.32)	.084 (1.30)	– .095 (– 1.47)	.264* (3.70)	.041 (.57)	.123 (1.78)	.015 (.21)
May 1982	.218* (3.46)	.049 (.78)	.240* (3.78)	– .004 (– .06)	.157* (2.17)	.026 (.36)	.117 (1.71)	.024 (.35)
July 1982	—	—	.192* (2.86)	.060 (.89)	—	—	.148 (1.83)	.129 (1.60)
Sept. 1982	.155* (2.23)	– .056 (– .81)	.073 (.96)	.127 (1.67)	.100 (1.09)	.060 (.65)	.071 (.85)	.073 (.87)
Nov. 1982	.077 (1.00)	.157* (2.04)	.015 (.21)	.069 (.98)	.041 (.36)	.155 (1.38)	.105 (1.29)	– .029 (– .36)
Jan. 1983	.024 (.34)	.179* (2.52)	.057 (.87)	.047 (.71)	.112 (1.12)	.192 (1.91)	– .011 (– .14)	.104 (1.34)

— = No contracts traded.
*indicates first- or second-order autocorrelation was significant at the 95-percent confidence level. The estimated equation was $u_t = r_1 u_{t-1} + r_2 u_{t-2} + e_t$, where u_t is the daily change in the log of price, and r_1 and r_2 are the autoregressive parameters.
[1]The value of the t-statistic for the null hypothesis that the parameter equals 0 is in parentheses.

Table 7—Autoregressive parameter estimates: Sunflower seed and soybeans[1]

Contract maturity	Sunflower seed				Soybeans	
	Closing price		Opening price		Closing price	
	First order	Second order	First order	Second order	First order	Second order
July 1980	0.214 (1.56)	0.004 (.03)	0.127 (.90)	0.108 (.77)	−0.061 (−1.05)	0.031 (.54)
Nov. 1980	.083 (.98)	.065 (.77)	−.042 (−.49)	.023 (.27)	−.041 (−.70)	−.067 (−1.16)
Jan. 1981	.172 (2.30) *	.074 (.98)	−.024 (−.31)	.102 (1.30)	.046 (.79)	−.038 (−.65)
Mar. 1981	.024 (.35)	.026 (.39)	−.150 (−2.05) *	.003 (.73)	.001 (.02)	.015 (.25)
May 1981	.082 (1.33)	−.041 (−.66)	−.148 (−2.30) *	−.089 (−1.37)	.007 (.12)	−.072 (−1.23)
July 1981	.040 (.63)	−.006 (−.10)	−.038 (−.48)	−.240 (−3.05) *	−.016 (−.27)	−.068 (−1.17)
Nov. 1981	.061 (.92)	−.083 (−1.26)	−.048 (−.60)	−.083 (−1.03)	−.012 (−.21)	−.047 (−.81)
Jan. 1982	−.050 (−.80)	.005 (.08)	−.082 (−.59)	−.075 (−.54)	−.008 (−.13)	−.045 (−.78)
Mar. 1982	.083 (1.30)	.129 (2.02) *	.078 (.53)	−.072 (−.49)	−.096 (−1.64)	−.051 (−.88)

— = No contracts traded.
*indicates first- or second-order autocorrelation was significant at the 95-percent confidence level. The estimated equation was $u_t = r_1 u_{t-1} + r_2 u_{t-2} + e_t$, where u_t is the daily change in the log of price, and r_1 and r_2 are the autoregressive parameters.
[1]The value of the t-statistic for the null hypothesis that the parameter equals 0 is in parentheses.

price changes would usually indicate an economically inefficient market.

Because closing prices were reported even if no trading occurred, tables 6 and 7 also show the autoregressive estimates for opening prices. Two of the milled rice contracts (March and May 1982) showed significant first-order autocorrelation in percentage changes in opening price. The May contract had an unusually large number of deliveries, which indicates an efficiency problem. None of the percentage changes in rough rice opening prices was significantly autocorrelated at the 95-percent confidence level. The high degree of autocorrelation found among the changes in closing prices in both markets is a feature common to thinly traded and inefficient markets. However, the low number of contracts where efficiency was rejected means that the null hypothesis of efficiency was not rejected for the group of contracts by the turning point or autocorrelation test when opening prices (those days in which trading occurred) were examined. For example, the probability, under the null hypothesis, that two of the nine milled rice contracts would reject the null hypothesis (assuming independence) is 7 percent, which is greater than the 5-percent significance level. The data from different contracts are not completely independent, because they overlap in time. Thus, the number of contracts rejecting the null hypothesis must be even greater before we could reject the null hypothesis of randomness for the group of contracts taken as a whole.

Futures may follow a higher order process. For example, there may be third-order autocorrelation or even a day-of-the-week effect (fifth-order autocorrela-

tion). I calculated Ljung-Box Q statistics for significance of coefficients of orders 1 through 5. The results are similar, but the apparent lack of autocorrelation of degrees higher than 1 means that fewer Q values than first-order autocorrelation estimates are significant. As for changes in opening price, only the March 1982 rough rice, July 1982 milled rice, and May and July 1981 sunflower seed contracts had Q values which rejected the null hypothesis (tables 6 and 7).

Forecast Accuracy

An important characteristic of an efficient futures market is that market's ability to predict prices in an accurate and unbiased manner. Tests of forecast accuracy for futures market prices have become common in the past 15 years. In 1970, Tomek and Gray used a forecast accuracy test to examine the efficiency of the potato futures market (*25*). Since then, many others have examined commodity futures markets with this test. See, for example, (*14*) and (*16*).

A futures market should ideally provide an unbiased estimate of the price actually occurring in the delivery month. To study this matter, one typically regresses the futures price on one day during the delivery period at harvest on the futures price at an earlier time—for example, at planting. Because the difference between the futures price at harvest and the cash market price at harvest (the basis at maturity) varies considerably from year to year (because of changing factors such as transport cost and storage space cost), forecast accuracy tests usually test the futures price in the earlier period against the futures price at harvest rather than the cash price at harvest. Observations on these two variables covering several years are collected and yield the following equation:

$$F_{D,t} = a + bF_{D-i,t} + e_t \tag{2}$$

where:

$F_{D,t}$ is the futures price at delivery time in year t, $F_{D-i,t}$ is the futures price i periods before delivery in year t, and e_t is the residual in year t.

If the earlier price is an unbiased estimate of the harvest price, coefficient a will equal 0 and coefficient b will equal 1. If the values of a and b are different from 0 and 1, then the futures market is said to give a biased estimate of the delivery price. This cannot happen in an efficient market because the bias implies that someone could use the equation to profit at the expense of other market participants. For example, if some traders knew that today's estimate of next fall's price is too high, they would sell the commodity short and expect to make large profits.

Because the futures markets for rice and sunflower seed were open for only a short time, the forecast accuracy test cannot be applied to planting time estimates of the price at harvest. There are only enough data to allow testing the forecast of the next-to-last month price for the delivery month price and the forecast given by the price 2 months earlier for the delivery period price.

If all possible forecasts are used, the price forecasts 3 months or more into the future will overlap. That is, the same random events will affect at least two of the forecasts at a time. The reliability of the June forecast for the September contract and the April forecast for the July contract are both affected by random events occurring from mid-June to mid-July. The overlap means that the errors from the two forecasts will not be independent. In fact, the errors from the forecast regression will tend to be autocorrelated. To regain independence, one must drop some of the forecasts or explicitly account for the nature of the interdependence. The aggregation of overlapping forecasts without an acknowledgment of the resulting interdependence of the observations in the equation is a common error in the forecast accuracy literature for agricultural commodities.

Table 8 shows the results of these regressions. One needs a simultaneous test of the slope and intercept coefficients to evaluate the forecast accuracy of the futures markets, as well as tests on individual coefficients. In each regression, I calculated the F-statistic for the joint null hypothesis that (a,b) = (0,1) and compared it with the tabulated values. I used the daily closing price on the 15th of the month (or the nearest day where trading occurred) as the representative futures price.

The F-values rejected the null hypothesis of efficiency for the 2-month-ahead forecast for milled rice and 1-month-ahead forecast for rough rice at the 95-percent confidence level. The calculated F-statistics did not

Table 8—Forecast accuracy of closing prices[1]

	Equation	R^2	DW / DFE	F-test
Milled rice				
(1)	Outcome = 2.749 + 0.820 $Pred_1$	R^2 = 0.927	DW = 2.29	F(0,1) = 4.12
	(1.642) (0.086)		DFE = 7	Pr > F = 0.066
(2)	Outcome = 4.033 + 0.724 $Pred_2$	R^2 = 0.934	DW = 2.34	F(0,1) = 19.06#
	(1.427)* (0.078)*		DFE = 6	Pr > F = 0.003
Rough rice				
(1)	Outcome = 1.656 + 0.829 $Pred_1$	R^2 = 0.960	DW = 1.92	F(0,1) = 4.55#
	(0.564)* (0.057)*		DFE = 9	Pr > F = 0.043
(2)	Outcome = 2.711 + 0.697 $Pred_2$	R^2 = 0.787	DW = 1.95	F(0,1) = 3.29
	(1.236) (0.128)*		DFE = 8	Pr > F = 0.093
Sunflower seed				
(1)	Outcome = 8.713 + 0.306 $Pred_1$	R^2 = 0.141	DW = 1.28	F(0,1) = 4.14
	(3.214)* (0.267)*		DFE = 8	Pr > F = 0.058
(2)	Outcome = 7.738 + 0.376 $Pred_2$	R^2 = 0.208	DW = 1.38	F(0,1) = 2.91
	(3.213)* (0.259)*		DFE = 8	Pr > F = 0.112
Soybeans				
(1)	Outcome = 12.038 + 0.991 $Pred_1$	R^2 = 0.819	DW = 0.82 +	F(0,1) = 0.21
	(79.27) (0.117)		DFE = 16	Pr > F = 0.813
(1a)	Outcome = 41.069 + 0.946 $Pred_1$	R^2 = 0.751	Rho = 0.56	
	(95.20) (0.141)		(0.19)	
(2)	Outcome = 132.98 + 0.782 $Pred_2$	R^2 = 0.614	DW = 1.76	F(0,1) = 2.05
	(109.6) (0.155)		DFE = 13	Pr > F = 0.162

Notes: DW is the Durbin-Watson statistic. Values significant at a 95-percent or greater confidence level are marked with +. DFE are the degrees of freedom of the estimate. Rho is the estimated first order autocorrelation. Standard errors are in parentheses. F(0,1) is the value of the test statistic for the null hypothesis that (a,b) = (0,1). *indicates that the t-value rejected the null hypothesis of no bias for this coefficient at a 95-percent or greater confidence level. #indicates that the F-value rejected the null hypothesis that the parameters are (0,1) at a 95-percent or greater confidence level.

[1]Outcome is the closing price on the 15th of the delivery month.
$Pred_i$ is the closing price on the 15th of the ith month before delivery i = 1,2.

reject the null hypothesis both for forecasts for sunflower seed and for the 2-month-ahead forecast for rough rice. But, in these cases the t-values for the null hypothesis on the slope and intercept terms individually rejected efficiency in every case but one. The short history of these futures markets means that there are few degrees of freedom in the forecast accuracy tests. The fewness of degrees of freedom (and the low value of R^2 in the case of sunflower seed futures) partly account for the lower rejection rate by the F-test than by the individual t-tests. Neither the F-test nor the t-tests rejected the null hypothesis of forecast accuracy for the 1-month-ahead forecast for milled rice.

For comparison, I calculated 1- and 2-month-ahead forecasts for soybean futures during the 1980-82 period. The August contract in each year was omitted to prevent overlap in the 2-month-ahead forecasts. The efficiency hypothesis could not be rejected with either the 1- or 2-month-ahead forecast in the soybean futures market. The 1-month-ahead forecast showed autocorrelation in the residuals, but when

corrected for the first-order autocorrelation still gave an unbiased forecast.[6]

Thus, several market prices for rice futures and sunflower seed futures 1 and 2 months prior to delivery were not unbiased predictors of their delivery month values. The F-test rejected efficiency in fewer equations than did the t-statistics on the slope and intercept terms. There are not enough data to test whether the spring price was a biased estimate of the fall price, but the results of the t-tests on the slope and intercept coefficients suggest that the 1- and 2-month-ahead forecasts show a bias towards the mean in their price predictions. The slope coefficients were significantly less than 1, which means that the price forecasts overestimate the deviation of subsequent prices from the mean. A profitable strategy would be to bet that price would return to its longrun level whenever there were wide swings in expected value.

One reason for the low estimates of b may be that the within-day variation in price in thin markets (due to the effect of buy-and-sell orders in moving market price) is large relative to day-to-day changes caused by changing expectations. That is, the lack of forecast accuracy in thin markets may reflect an errors-in-variables problem. In heavily traded markets, price movements due to buy-and-sell orders within a trading day may be smaller than in thin ones, relative to day-to-day price movements due to the arrival of new information.

Gray has suggested that thin markets will show bias (*7*). The results here tend to support his hypothesis. If the markets were to become more active, the forecast bias would presumably shrink and eventually disappear. Because of the higher entry and exit costs of a thin market in contrast to a liquid one, the ability of any arbitrager to profit from the bias would be limited.

[6]Autocorrelation in the residuals suggests an inefficient market, despite the lack of bias. The autocorrelation information could be used profitably by arbitragers. I estimated forecast accuracy of the 1-month-ahead forecast for soybeans from a longer time series (1959-82) to see if autocorrelation was typical of soybean forecasts. The resulting equation shows that the soybean forecast was not representative over the period when rice and sunflower futures were traded.

$$\text{Outcome} = \underset{(9.09)}{15.42} + \underset{(0.018)}{0.968}\ \text{Pred}_1 \qquad R^2 = 0.946$$

$$\text{DFE} = 159 \qquad F(0,1) = 2.98$$

$$\text{DW} = 2.10 \qquad \Pr > F = 0.087$$

Conclusion

Several statistical tests have shown that three thinly traded futures markets—milled rice, rough rice, and sunflower seed—retain some (but not all) of the pricing and hedging characteristics of more heavily traded markets. The three markets exhibited randomness in day-to-day price changes. Without this property they would have little value to the potential hedger. Their hedging performance, as measured by the basis regressions, was mixed.

The forecast accuracy test is perhaps the most important one. Many farmers base their expectations of future supply, demand, and price on futures market quotations, whether or not they participate in futures trading. The apparent tendency for futures prices in thin markets to overreact to changes in supply and demand significantly lowers their value to producers.

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Economic Impacts of Increased Price Variability: A Case Study with Rice

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Abstract

This article investigates the impacts on the rice industry of increased price variability caused by the shift from stable economic conditions and a farm policy of supply control in the sixties to more variable economic conditions and a market-oriented farm policy in the seventies. The increased price variability associated with these changes has significantly increased marketing margins for rice. These policy and economic changes reduce the probability that Texas rice producers will remain solvent for 10 years.

Keywords

Marketing margins, producer viability, price variability, policy changes, economic changes, rice

Introduction

Agricultural legislation on rice dates from the early thirties with the enactment of the Agricultural Adjustment Act (Public Law 10, 73rd Congress) of 1933 (*8*).[1] The basic agricultural legislation currently affecting the rice industry had its origin in the Agricultural Adjustment Act of 1938 (Public Law 430, 75th Congress). The 1938 act attempted to stabilize rice supplies and prices through acreage adjustments, Government loans, and regulated marketing quotas. The first loan activities or Government purchases occurred in 1948. Acreage allotments and marketing quotas were instituted in 1955. The industry operated under a price-support/acreage allotment/marketing quotas program through 1975. With the passage of the Rice Production Act of 1975, Congress changed the farm program for rice from supply control through marketing quotas and allotments to a market-oriented program with deficiency payments based on the difference between a weighted August-December farm price, the loan rates, and the target price.

U.S. Government programs stabilized domestic prices from 1955 through 1971 (see figure). The world rice situation from 1972 to 1974 was characterized by reduced exportable supplies and increased import demand. U.S. prices began to climb during the fall of 1972 toward the highest nominal price ever recorded. The sharp rise in prices triggered a suspension of domestic marketing quotas for the 1974 and 1975 crops and opened the way for expansion of U.S. rice acreage. The shift to target price programs in 1976 emphasized deficiency payments as a means of income support to producers. If the farm program of the sixties had continued to the present, U.S. rice prices would have restabilized after the 1972-74 rise in world prices. Prices supported at 65 percent of parity would have exceeded the farm price every year since 1975, except for 1977. The change in the market environment between 1960-71 and 1976-82, triggered by a change in economic conditions and coupled with a change in farm policy for rice, has seriously affected the rice industry. In this article, we evaluate the effect of the shift in farm policy and economic environment on (1) marketing margins and (2) producer viability. We examine the margin be-

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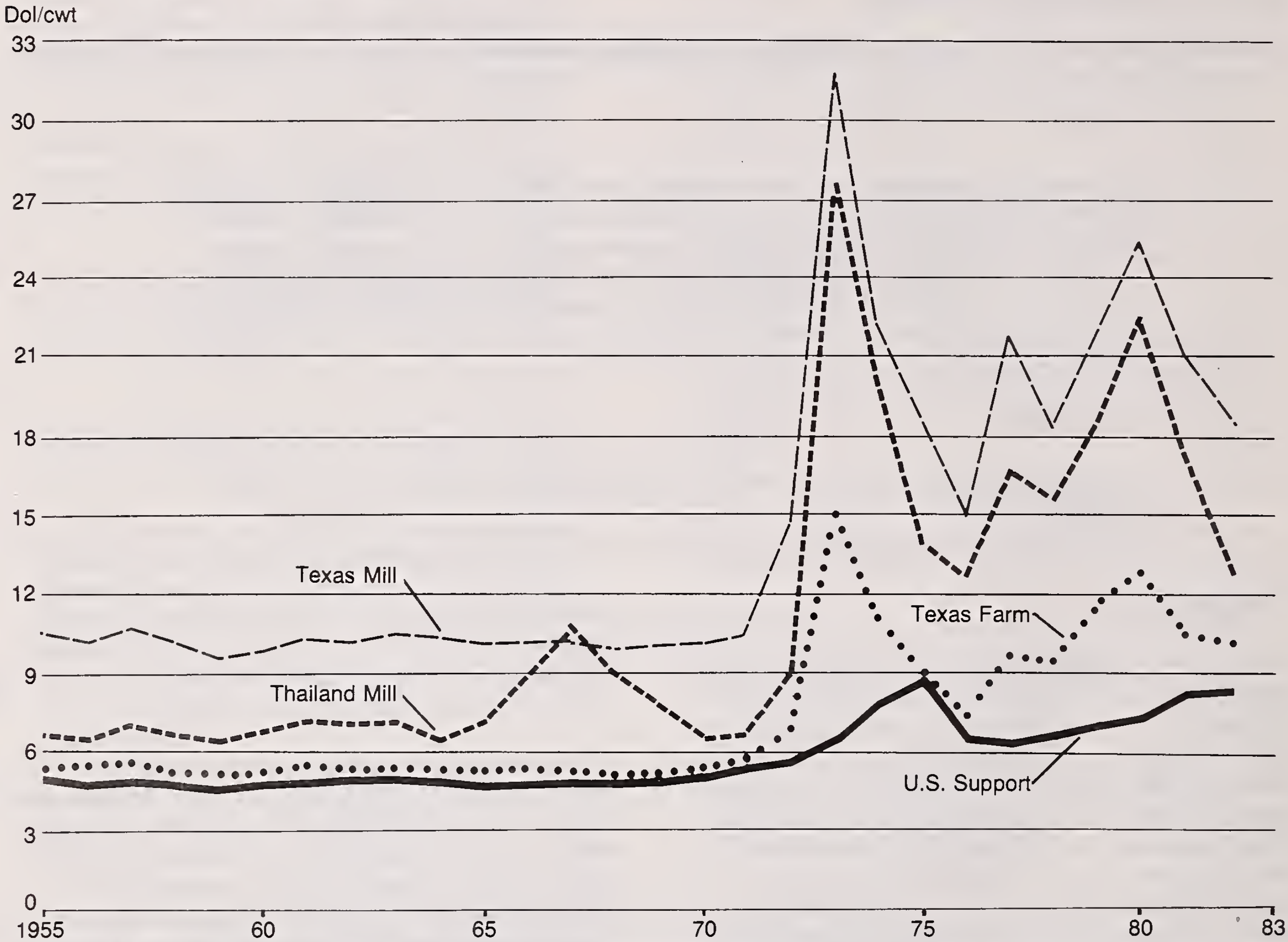
[1]Italicized numbers in parentheses refer to items in the references at the end of this article.

Season Average Rice Prices, 1955-82



tween farm and mill prices and the variability of farm and mill prices.[2] We estimate the survivability of Texas rice producers using the Firm Level Income Tax and Farm Policy Simulator (FLIPSIM V) (*11*).

Impact of Price Variability on Marketing Margins

If mills are risk averse, then increases in price variability should increase farm-mill marketing margins. The price-support/acreage control program during 1960-71 stabilized U.S. prices to the extent that the rice industry experienced little risk from price variability (see figure). The taxpayer assumed this risk through the cost of the Government farm program. As prices rose sharply in 1973, price variability increased. The change in the economic environment and the changes in the rice farm program in 1974 and 1976 forced both millers and producers to contend with chronic increased price variability (*6*).

Theoretical Model

Gardner has developed a theoretical model of price determination between levels of a marketing channel (*4*). He contends that prices are determined by retail

[2]A continuous price series for retail rice for both periods is not available. Thus, margins between mill and retail prices are not used.

demand, farm supply, and the supply of marketing services. If mills are risk averse, then a change in price variability would be expected to shift the supply of marketing services. Gardner's model assumes a competitive market. Because of the concentration of rice mills in the Texas rice area, rice milling is probably not perfectly competitive. The assumptions of perfect competition are stronger than needed for a firm to behave as a price taker.

Baumol and others have proposed perfect contestability as a generalization of perfect competition. They showed that a market is contestable if entrants can reverse their investments without loss and suffer no disadvantages relative to incumbents. Although the assumptions of a contestable market are rather demanding, especially in the short run, they may provide a plausible approximation for many concentrated industries (see (*1*)). Under the hypothesis that the mere threat of entry makes firms behave as if they were price takers, it is appropriate to explore the implications of price uncertainty in the rice marketing channel.

The supply of marketing service is written in price dependent form as:

$$S = f_1(Q,V,Z) \tag{1}$$

where S is the margin, Q is quantity milled, V is a measure of price variability, and Z is a set of exogenous shifters (in this case, milling costs). The quantity supplied at the farm (Q_f^s) is:

$$Q_f^s = f_2(P_f,X) \tag{2}$$

where P_f is the farm price and X is a set of exogenous shifters (for example, yield). The quantity demanded at the mill level (Q_m^d) is:

$$Q_m^d = f_3(P_m,Y) \tag{3}$$

where P_m is mill price and Y is a set of exogenous shifters (for example, population, income, and world rice production). The system is completed by the following identities:

$$P_f = P_f^s = P_m - S \tag{4}$$

$$Q = Q_f^s = Q_m^d \tag{5}$$

The inverse supply of marketing services (equation (1)) can be estimated directly, assuming quantity is determined exogenously as most rice produced is milled in the same crop year (*13*). In addition, production of rice, like most other crops, is related to lagged price rather than to current price; thus, quantity is exogenously determined (*7, 16*). The incidence of a change in margin can be determined by a method like Fisher's (*3*). After obtaining estimates for equation (1), one can then obtain the impact of increased price variability on the margin by totally differentiating equation (1):

$$dS = \frac{\partial f_1}{\partial Q} dQ + \frac{\partial f_1}{\partial V} dV + \frac{\partial f_1}{\partial Z} dZ \tag{6}$$

If dQ and dZ are assumed to be zero, then equation (6) can be solved for the change in margin with a change in price variability. By equating the quantities in equations (2) and (3) and totally differentiating, one obtains:

$$\frac{\partial f_2}{\partial P_f} dP_f + \frac{\partial f_2}{\partial X} dX - \frac{\partial f_3}{\partial P_m} dP_m - \frac{\partial f_3}{\partial Y} dY = 0 \tag{7}$$

By assuming dX and dY to be zero and writing equation (7) in elasticity form, one obtains:

$$e_s \frac{dP_f}{P_f} - e_d \frac{dP_m}{P_m} = 0 \tag{8}$$

where e_s is the elasticity of farm supply and e_d is the elasticity of mill demand. By totally differentiating equation (4), one obtains:

$$dP_f = dP_m - dS \tag{9}$$

Equations (8) and (9) can be solved for dP_f and dP_m, given e_s, e_d, P_m, P_f, and dS.

We used unweighted season-average prices and monthly prices received by Texas farmers (*14*) and Texas mills (*12*) for 1960-82 crop years to evaluate price variability. A continuous monthly series is not available for retail prices. We estimated the missing data in the monthly Prices Recieved by Texas Farmers (September 1976-July 1979) by regressing the Texas price on the monthly prices received by U.S. farmers (January 1960-July 1982).

We used annual Texas mill price (adjusted to a rough rice equivalence by a factor of 0.71) and annual Texas farm prices to calculate the margins. We estimated the supply of marketing services by regressing the margins against quantity and shifters of the supply of marketing services. Annual quantity milled in Texas was used as the quantity moving through the marketing channel (*13*). This quantity is assumed to be exogenously determined. The coefficient of variation of monthly Texas mill prices within each marketing year was used to represent price variability. Mills usually maintain short-term inventories (1-2 months) and should, therefore, be influenced by short-term price variation. Milling costs were used to represent the other shifters of the supply of marketing services. Data on milling costs were available only for 6 years during 1960-82 (*8*). The available data were regressed against an unpublished data series on the cost of milling wheat flour, and the missing rice mill costs were then estimated from this equation.

The elasticity of rice production with respect to farm price ranged from 0.15 in Texas to 0.50 in Arkansas and averaged 0.35 for the United States in 1975 (*7*). The U.S. elasticity of demand with respect to the Texas long grain mill price was −0.83. Brorsen has shown that rice prices in different locations nationwide follow each other very closely (*2*). So demand response in Texas should be similar to that in other areas of the Nation. The low elasticity of production for Texas relative to that for other States, however, indicates the possibility of a differing response to price changes. Given these elasticities and the estimated supply of marketing services, the portion of the increased margin that would be shifted to the producer can be calculated from equations (8) and (9).

Results

In accordance with Gardner's model, we attempted to associate the observed widening of the Texas mill-farm marketing margin during the seventies with the respective factors of importance—that is, quantity of rice milled, milling cost, and a measure of the increased rice price variability. The estimated inverse supply of marketing services was:

$$\begin{aligned} MAR = \; & \underset{(.43)}{-0.3820} + \underset{(.26)}{0.0149\,QM} + \underset{(2.24)}{0.1132\,VARTX} \\ & + \underset{(2.50)}{2.1614\,MILLC} \end{aligned} \tag{10}$$

where MAR (for example, marketing margin) is the Texas mill price adjusted to a rough rice equivalence minus the Texas farm price (dollars per hundredweight (cwt)), QM is the annual quantity of rice milled in Texas (million cwt rough rice), VARTX is the annual coefficient of variation of monthly milled prices in Texas, and MILLC is an estimate of annual milling costs (dollars per cwt rough rice). R-square for equation (10) equals 0.694. The t-statistics are in parentheses under their respective regression parameter estimates. The variable representing price variability over the data period, VARTX, is significant and positive, indicating mills are risk averse. In his analysis of mill buying response in bid/acceptance markets, Meyer also found that rice mills were risk averse; that is, they reduced their bids for rough rice when faced with a higher level of price volatility (*9*). The variable representing rice milling cost over the data period, MILLC, is positive and significant as expected. The effect of quantity milled was insignificant.

These results show the widening in the farm-mill price margin is significantly associated with the increase in price variability accompanying the economic changes and market-oriented farm policy emphasis of the seventies. The increased variability in Texas mill prices (average coefficient of variation shifting from 1.57 in 1960-71 to 8.97 in 1976-82) implies an increase mill-farm margin of 0.84.[3] The average farm price in 1976-82 was $9.71 per cwt, whereas the average Texas mill price for the same period was $20.35 per cwt. Use of these price levels and the earlier discussed elasticities (production at 0.15 and demand at −0.83) in equations (8) and (9) shows that increased price variability increases retail prices by $0.23 per cwt and decreases farm prices by $0.61 per cwt. Substitution of the U.S. elasticity of production (0.35) for the Texas elasticity (0.15) shows the increased price variability for the United States increases retail price by $0.39 per cwt and decreases farm price by $0.45 per cwt; that is, mills in non-Texas rice areas tend to pass more of the margin change to the consumer.

Increased market price variability and wider mill-farm marketing margins suggest rice producers are

[3]Estimating the margin equation with price/cost variables deflated by the Consumer Price Index results in an even higher impact on mill-farm margins ($1.11 when reinflated to the average price level of the 1976-82 period).

confronted with major marketing and production problems under the current Government program. One needs to focus on production costs, marketing margins, and alternative land tenure arrangements to address the issue of which parties (owner-operator producers, tenants, or landlords) are most adversely affected by increased rice price variability. In addition to reducing farm prices, the shift in policy emphasis and economic changes have increased farm price variability and may significantly reduce producers' chances of survival.

Impact of Policy and Economic Changes on Producer's Viability

We now examine how increases in the price variability of rice and marketing margins affect producer viability.[4] We evaluate the ability of gulf coast rice producers in Texas to internalize increased price risk and marketing margins by stochastically simulating a typical size rice farm under the policy provisions of both the sixties and seventies. Because the impacts of price risk are hypothesized to depend on tenure arrangements, we evaluated three tenure arrangements: (1) full owner, (2) part owner, and (3) tenant.

Method

We used the Firm Level Income Tax and Farm Policy Simulator (FLIPSIM V) to analyze a typical size rice farm in Texas. The computer model is a firm-level, recursive, Monte Carlo simulation model which simulates the annual production, farm policy, marketing, financial management, and income tax aspects of a typical farm over a 10-year planning period. The model simulates the farm operation recursively by using the ending financial position for 1 year as the beginning financial position for the next year. The Monte Carlo aspect of the model comes from repeating the 10-year planning period for 50 iterations using random crop prices and yields drawn from empirical probability distributions.

[4]Viability in this case refers to the probability the farm will be economically successful and will be able to survive 10 years. Probability of success is measured as the probability the farm will generate sufficient income and retained earnings to have a positive after-tax present value of net family withdrawals and change in net worth. If one assumes a real discount rate equal to 4 percent, the probability of success indicates the chance a farm will provide a 4-percent (or greater) real return to initial equity. Survival in this case is defined as the farm's remaining solvent for 10 years, maintaining equity ratios greater than the minimums established by local financial institutions (0.33).

Richardson and Nixon have described and documented an earlier version of FLIPSIM (*11*). The version of FLIPSIM used for this study was revised to include the provisions of both the 1982 income tax act and the 1981 farm bill. We used the model to simulate typical full owner, part owner, and tenant-operated rice farms in Texas under two scenarios: (1) the farm program and economic environment during 1960-71, and (2) the farm program and economic environment during 1976-82. We used the same assumptions about machinery depreciation (cost recovery), family size, family consumption, income tax and social security schedules, machinery replacement, interest rates, growth, and inflation rates for both scenarios.

Gerlow provided the necessary information to model a typical gulf coast rice farm in FLIPSIM (*5*). The typical farm has 1,700 acres. Rice is planted on the same cropland every other year and idle cropland is cash leased for grazing. This crop mix yields 850 acres of rice each year.[5] The operator has an initial debt-to-asset ratio of 40 percent. The part owner owns 412 acres of cropland and leases the remaining cropland on a share lease. Landowners typically receive 10 percent of the crop and pay 10 percent of the total grain-drying cost (*5*).

The simulation model was run assuming all costs, mean prices, and policy parameters were held constant throughout the planning period. Long-term interest rates were 10 percent and intermediate interest rates were 12 percent. Given these assumptions of real prices, land values were held constant at their 1982 levels.

A bivariate probability distribution for rice yield (first crop and second crop) was developed from producer yields in the Texas gulf coast. We used Gerlow's actual farm yields for 5 years (1977-81) to develop empirical distributions for first and second crop rice yields.[6] Table 1 summarizes the empirical probability distribution for rice yield regarding the

[5]The 1978 Census indicates farms harvesting 500 or more acres of rice harvested 64 percent of rice total acres. This group of farms averaged 853 acres of rice harvested, only 3 acres more than our typical size farm.
[6]Actual yields for farms in the study area are not available prior to the 1977 crop year. The empirical distributions generated using data from 1977-81 are consistent with producers' subjective distributions for 1983 rice yields.

Table 1—Probability distribution of rice yields and prices for Texas gulf coast rice producers

Item	Rice yields		Rice prices			
	First crop	Second crop	1960-71		1976-82	
			July	January	July	January
	-- *Cwt* --		--------- *Dol./cwt* ---------			
Mean	45.82	11.36	5.09	4.77	9.28	8.89
Ranked deviation from the mean:						
1	-4.89	-11.36	-0.74	-0.75	-2.76	-2.83
2	-3.82	-4.56	-.41	-.29	-2.64	-2.65
3	-3.12	-2.47	-.21	-.10	-2.53	-2.47
4	-2.00	.39	-.11	-.02	-1.23	-1.91
5	-.87	.85	-.09	.00	-.39	-.77
6	.83	2.96	.10	.09	-.20	.15
7	2.37	3.52	.16	.09	.43	1.29
8	3.02	4.41	.20	.10	2.05	2.81
9	4.92	5.32	.31	.20	3.18	3.29
10	6.50	5.71	.40	.37	4.32	3.79
			Coefficients			
Correlation coefficient—						
For first and second crop price	0.44					
For sixties' July and January price			0.54			
For seventies' July and January price					0.90	

means and ranked deviations from the means. Yield for the second crop is correlated (0.44) to yield for the first crop in the simulation model. We used the bivariate yield distribution reported in table 1 for both policy scenarios.

Rice producers in the Texas gulf coast have many marketing strategies. It was assumed operators do not change their marketing practices between the two scenarios despite increases in price risk and marketing margins. The typical strategy is to sell after harvest. Thus, the first crop is sold in July and the second crop is sold in January (*5*). To simulate this practice, we developed an empirical bivariate probability distribution for July and January rice prices for 1960-71 and 1976-82 (table 1). We used averaged January and July rice prices received by Texas producers for the two periods to develop price distributions. January prices were reduced 7 percent as the second crop (sold in January for this study) is of poorer quality than the first crop (*5*).

Under the policy and economic scenario of the sixties, farmers have a 688-acre rice allotment and it is assumed they cannot plant rice in excess of this allotment—that is, an effective marketing quota based on acreage. Grain sorghum is assumed to be planted on the cropland without a rice allotment (162 acres).[7] The acreage allotment under the farm policy of the seventies is 748 acres of rice, and the allotment determines only the portion of the crop eligible for price supports and deficiency payments. These allot-

[7]Budgets developed by the Texas Agricultural Extension Service for the gulf coast area were used in the model. Prices and yields for sorghum were assumed to be random and to follow their historical distribution. We developed distributions for sorghum yields and prices in the same manner that rice distributions were developed.

ments were estimated based on Texas allotments for rice between 1960 and 1980, acres of rice planted, and acres of cropland for a typical farm.[8]

The average nominal loan rate in 1960-71 was $4.68 per cwt (91.9 percent of the average price in July). In 1976-82, the average nominal loan rate was $6.98 per cwt and the average nominal target price was $9.30 per cwt (71.7 and 95.6 percent of the average price in July, respectively). To compare the typical farm under the two scenarios, we scaled both the price distribution and the average loan rate for the old policy to levels comparable to the 1976-82 rice program. The empirical price distribution for 1960-71 (table 1) was scaled to yield the same mean as the new policy ($9.28 for July and $8.89 for January) plus the marketing margin adjustment for Texas producers ($0.61 per cwt). We adjusted for marketing margin because returning to the old scenario would reduce both the price variability and the marketing margin, thus increasing the mean price received by Texas rice producers. Given this price adjustment, we increased the loan rate for the old rice policy to $9.09 per cwt, or 91.9 percent of the adjusted mean price ($9.89 per cwt). The average rice price (table 1) and the average loan rate and target price for 1976-82 were used in the simulation model for the latter policy and economic environment.[9] All mean prices (January and July) and policy variables (loan and target prices) were held constant over the 10 years simulated for both farm policies.

Simulation Results

Simulation results for three tenure arrangements show that lower price variability and smaller marketing margins under conditions in the sixties generally resulted in greater producer viability (success and survival) than under conditions in the seventies (table 2). For a tenant rice producer with 1,700 acres of cropland, conditions in the latter period provide a 94-percent chance of economic success (providing a 4-percent (or greater) return to initial equity) compared with a 100-percent chance in the earlier period. A part owner has an 82-percent chance of success under the new scenario versus a 100-percent chance under the old scenario. Because of the high debt level on cropland ($600,000), the full owner has a low probability of receiving a positive net present value under both scenarios.

The probability that tenant farm operators will remain financially solvent (survive) for 10 years is reduced from 86 percent under the scenario in the sixties to 56 percent under the scenario in the seventies. The probability of survival decreased from 98 percent to 82 percent for the part owner-operator. The probability of survival was about 100 percent for the full owner under both scenarios because of the high initial net worth of the operator (60 percent equity in 1,700 acres of cropland). The part owner's equity in 412 acres of cropland similarly contributed to a higher probability of survival relative to the tenant-operated farm.

Average after-tax net present value for tenant rice farmers is about $120,000 less under the condition in the seventies (table 2).[10] For part owners, average after-tax net present value is greater by $98,000 under the conditions in the seventies. This value is also greater for full owners. The scenario of the seventies is associated with greater average after-tax net present values for part and full owners because these operators receive all or most of the benefits from deficiency payments, whereas the tenant shares the benefit of the farm program with the landlord.

Conditions in the seventies resulted in greater absolute and relative variance in after-tax net present value (table 2). The relative variance in after-tax net present value for part owners more than doubled as a result of policy and economic changes. The other tenure arrangements produce similar results.

[8]Under the sixties program, planted acreage of rice in Texas was 88.4 percent of the Texas rice allotment (*6*). Under the seventies' program, Texas producers overplanted their allotment by 14.7 percent on average. Given that farmers produce 850 acres of rice under the seventies' policy, their allotment is 748 acres. Prorating the 748-acre base under the seventies' program by the ratio between the average rice allotment for Texas under the sixties' program (460,300 acres) and the seventies' program (500,000 acres) yields the farmer's rice allotment of 688 acres under the policy of the sixties.

[9]The national loan rates were converted to a long-grain loan rate consistent with the actual loan rate for Texas rice.

[10]After-tax net present value is the discounted stream of family withdrawals and changes in the net worth for the farm operation over the 10-year planning period.

Examining the extremes of the after-tax net present value and ending net worth distributions reveals that these distributions are skewed much more to the right in the seventies than in the sixties. For a part owner, the minimum after-tax net present value is $93,000 less than for the environment in the seventies, while the maximum is about $385,000 greater. Results for the tenant and the full owner are similar. These distributions were shifted to the right because of the benefits of the rice policy in the seventies (deficiency payments and price supports) and the increased price variability from changes in the policy and economic situation. The farm program benefits provided income and price protection from the increased price variability, whereas the increased price variability provided an opportunity for high prices and returns. Reduced probabilities of success and survival for tenants and part owners suggest, however, that the farm program benefits were not sufficient to compensate tenants and part owners for the increased price variability and the marketing margin change.

The financial well-being of part owners and tenants in Texas gulf coast rice-producing areas has worsened. Given the same interest costs, credit availability rules, and income tax schedules, the environment of the seventies is associated with higher average ending leverage (debt/equity) ratios for these farm operators (table 2). The average ending leverage

Table 2—Effects on Texas rice farmers of policy and economic environments of 1976-82 and 1960-71

Item	Full owner		Part owner		Tenant	
	1976-82	1960-71	1976-82	1960-71	1976-82	1960-71
	1,000 dollars					
After tax net present value:[1]						
Mean	5.04	–156.19	356.48	258.45	460.39	580.68
Standard deviation	208.56	107.04	235.89	89.32	393.77	217.74
Minimum	–438.39	–429.10	–84.48	8.39	–35.42	38.68
Maximum	533.33	104.45	856.25	471.16	1,208.79	837.40
Present value of ending net worth in year 10:						
Mean	976.18	814.61	570.72	451.94	480.26	553.29
Standard deviation	207.84	107.04	200.68	88.38	315.32	159.01
Minimum	540.56	541.73	202.70	218.44	90.91	165.01
Maximum	1,504.12	1,075.25	1,049.40	664.32	1,156.38	784.99
	Percent					
Leverage ratio in year 10:						
Mean	0.65	0.78	0.69	0.46	1.36	0.45
Standard deviation	.37	.26	.81	.39	1.46	.77
Minimum	.23	.33	.09	.13	.02	.03
Maximum	2.00	1.51	2.65	2.40	4.00	2.42
Probability of success[2]	.54	.10	.82	1.00	.94	1.00
Probability of survival[3]	.98	1.00	.82	.98	.56	.86

[1]Net present value is the present value of net annual family withdrawals plus the present value of change in net worth over the 10-year planning period. After-tax net present value is largest for the tenant and smallest for the full owner because of the amount of initial equity each has invested, the amount of net gains each has from leasing idle land for pasture (none for the tenant), and the amount of retained earnings for each farm. Annual interest and principal payments on cropland for the full owner exceed the annual crop share rental cost of tenants who have greater annual retained earnings.

[2]Probability of success is the probability that net present value will be greater than or equal to zero, assuming a discount rate of 4 percent.

[3]Probability of survival is the probability that the farm will remain solvent for 10 years.

Table 3—Effects on Texas rice farmers of changes in the marketing margin due to an increase in price variability

Item	Full owner		Part owner		Tenant	
	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted
	1,000 dollars					
After tax net present value:[1]						
Mean	– 156.19	– 368.90	258.45	67.94	580.68	425.63
Standard deviation	107.04	102.10	89.32	91.26	217.74	200.43
Minimum	– 429.10	– 552.98	8.39	– 116.67	38.68	19.47
Maximum	104.45	– 96.59	471.16	302.79	837.40	699.45
Present value of ending net worth in year 10:						
Mean	814.61	603.95	451.94	275.88	553.29	408.51
Standard deviation	107.04	99.69	88.38	78.78	159.01	135.34
Minimum	541.73	417.81	218.44	142.48	165.01	145.80
Maximum	1,075.25	874.20	664.32	495.95	784.99	647.05
	Percent					
Leverage ration in year 10:						
Mean	0.78	1.39	0.46	1.31	0.45	0.59
Standard deviation	.26	.40	.39	.77	.77	.91
Minimum	.33	.56	.13	.17	.03	.02
Maximum	1.51	2.43	2.40	3.14	2.42	2.63
Probability of success[2]	.10	0	1.00	.76	1.00	1.00
Probability of survival[3]	1.00	.88	.98	.70	.86	.80

[1]Net present value is the present value of net family withdrawals plus the present value of change in net worth over the 10-year planning period. After-tax net present value is largest for the tenant and smallest for the full owner because of the amount of initial equity each has invested, the amount of net gains each has from leasing idle land for pasture (none for the tenant), and the amount of retained earnings for each farm. Annual interest and principal payments on cropland for the full owner exceed the annual crop share rental cost of tenants who have greater annual retained earnings.

[2]Probability of success is the probability that net present value will be greater than or equal to zero, assuming a discount rate of 4 percent.

[3]Probability of survival is the probability that the farm will remain solvent for 10 years.

ratio for tenant operators increased 200 percent because of policy and economic changes; the increase was 50 percent for part owners.

To isolate the impact of the marketing margin change on Texas rice producers, we simulated the typical farms under the provisions of rice policy in the seventies, but without the $0.61 per cwt marketing margin adjustment. The change in the marketing margin alone decreased the probability of survival for Texas rice producers (table 3). The increase in the marketing margin reduced probability of survival for tenant farmers 6 percentage points, from 0.86 to 0.80. For part owners, the decreased probability of survival was due to the increase in marketing margin of 28 percentage points, and the probability of survival for the full owner decreased 12 percentage points (table 3).

Average after-tax net present value for tenant farmers decreased 26 percent because of the increase in the marketing margin (table 3). Average after-tax net present value decreased more for the full owner and part owner than for the tenant. Average after-tax net present value decreased more for full owners because these operators pay the full per-unit production cost for sorghum and rice, whereas the tenant shares these costs and risk with the landlord. Net present value decreased because of the

higher marketing margin for all three tenure arrangements.

The simulation results indicate the new rice policy and economic environment of the seventies is not structurally neutral. The new environment reduces the chances of survival for tenant rice farmers more than it reduces the chances of survival for full owners and part owners. Because 57 percent of the rice farmers in the Texas gulf coast were tenant operators in 1979 (*10*), the new policy environment will likely contribute to a structural change among rice producers in Texas. Mullins, Grant, and Krenz indicate that approximately 47 percent of all U.S. rice farmers were tenant operators in 1979, so the new policy environment may cause similar changes in the structure of U.S. rice production.

Conclusions

The shift in the policy and economic environment between 1960-71 and 1976-82 significantly affected the U.S. rice industry in the following ways:

1. The industry had to contend with increased price variability. Coefficients of variation for Texas farm and mill prices increased fourfold or more.

2. The margin increase was related to the increased price variability. Changes in quantity milled had an insignificant effect on the margin increase. The amount of the margin change passed back to the Texas producer through a discounted price between the two periods was $0.61 per cwt.

3. The increased price variability plus a discounted farm price decreased the probability of survival from 98 percent to 82 percent for part owners and from 86 percent to 56 percent for tenant farmers in Texas.

4. The increased marketing margin for rice resulting from the policy and economic changes reduced the probability of survival 28 percentage points for part owners and 12 percentage points for full owners.

5. The new environment increased the absolute and relative variance in after-tax net present value for Texas rice producers.

6. Program benefits under the farm policy of the seventies were not sufficient to fully compensate part owners and tenant rice farmers in Texas for the increased price variability and the marketing margin change associated with the environment created by policy and economic changes.

7. The shift in policy during the seventies was biased against tenant rice farmers in Texas and will likely lead to structural changes among all rice producers.

8. Future policymakers should consider the impacts of alternative farm policies and economic actions on price variability and farm structure.

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In Earlier Issues

Most studies of portfolio or cropping program selection under uncertainty implicitly assume that the investor or manager is constrained only by propensity or aversion to risk. We argue that this is in fact not the case, but that the investor's capital limitations impose real restrictions on his admissible alternatives.

C. V. Moore and J. H. Synder
Vol. 21, No. 4, October 1969

Research Review

Agriculture in the Twenty-First Century

John W. Rosenblum (editor). New York: John Wiley & Sons, 1983, 415 pp., $27.50.

Reviewed by Charles V. Moore*

"As the world's population approaches 6 billion in the year 2000 the productivity and imagination of agriculturalists will be taxed as never before. Although there is more food being produced today than ever before, 70 to 80 percent of the earth's inhabitants exist on substandard diets, and 10 percent are near starvation" (p. xi). What a well written preface to a book about agriculture in the 21st century. What a challenge. How succinctly the problem of increased population is coupled with the problem of distribution. What reader would not want to complete this book to find out how such overwhelming problems are going to be solved?

Arthur R. Tanco, Jr., Minister of Agriculture, Republic of the Philippines, who wrote the prologue, motivates us further by admonishing us not to "allow the approaching drums of war to deafen us to the cries of the hungry, for hunger has killed more people than all the wars put together" (p. 1).

This is a book about agriculture and food. It is organized into five sections with 42 authors contributing 20 chapters based on a symposium at the Colgate Darden Graduate School of Business Administration of the University of Virginia. Any symposium organizer would be hard put to bring together a more impressive group of authors. Among the 42 contributors are 20 deans, directors, presidents, or vice presidents of colleges of agriculture, agricultural experiment stations, institutes, or their equivalents. In addition, a half-dozen department chairmen or holders of endowed chairs in universities have contributed their best thoughts. If these people don't have the answers, there probably aren't any.

Unlike many editors of symposia proceedings, this one has done a commendable job of introducing each section with a brief overview of the papers contained therein with an attempt to show how these papers interrelate and contribute to the sectional thrust.

Section 1 sets the stage, focusing on natural resources and agriculture with chapters on land, soil, forestry, energy, and public policy. Agricultural economists will find little new in this section; the old questions of property rights and limiting them for the public good, soil erosion, and multiple use of forest lands are predicted to still be with us in the next century. Missing is any recognition of the debate with the so-called school of public choice, which is flexing its political muscles of late and whose advocates within Federal resource management agencies have pressed for the sale of public lands, rapid expansion of oil and mineral leasing, and creation of markets for traditionally nonmarket goods. The reader will receive the first inkling from this section that the book's focus is not necessarily on world agriculture and global food supplies when clearly all contributors limit their remarks to domestic resource problems.

From section 2, "Agricultural Research and Technology," and section 3, "The Farmer of Tomorrow," one gets the sense that there is no food problem—that 70 to 80 percent of the world's population are not existing on substandard diets or that 10 percent are not at or near starvation dietary levels. The only apparent limiting factors are the lack of research funds, technical personnel, and computer software. Contributions in these two sections become the choreography for a technological pep rally complete with pom-pom shakers and marching bands. Technology will win tonight! One can even conjure up visions of a sub-Saharan peasant farmer in the next century sitting at his Apple II keyboard optimizing next year's production matrix.

Social scientists who, through dint of hard work and perseverence or by skipping willy nilly, somehow reach section 4, "Financing Agriculture," will be amply rewarded with some very perceptive contributions, especially from Walter Minger, senior vice president of Bank of America, who writes on "Capital Investment and the Business of Agriculture." Minger's forecast is, in this review's opinion, right on the mark: ". . . an increased debt burden and the

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cost of carrying such heavy liabilities will force the use of options other than the traditional farm financing instruments. Many farm and agribusiness balance sheets will be restructured to reflect the interests of owners, investors, short-term lenders, trade creditors, medium and long-term lenders, lessors, partners and joint venturers" (p. 259). This chapter alone is worth the price of the book.

With their vigor renewed, agricultural economists should be able to sail through the final section of the book, "The World Expectations for Agriculture." Dr. Gale Johnson's chapter on "Agriculture and U.S. Trade Policy," introduces the reader for the first time to the realization that everything doesn't always turn out the best in this, the best of all possible worlds. Policies that extend the self-interest of developed nations are often detrimental to the economic growth of developing countries. An excellent amplifying chapter by W. Arthur Lewis, "Developed and Developing Countries," further develop these policy conflicts.

The book ends on an upbeat note with an epilog which views agriculture of the 21st century as a giant cornucopia driven by the engine of technological innovation. Plants will produce their own fertilizer and livestock pests will die of starvation because of the lack of compatible hosts. Crops will grow in hitherto inhospitable environments, and a lonesome corporate farmer will prepare to plant the back 4,000 by slipping a floppy disk into the farm's computer.

Those who delight in reading tracts which gaze through an almost Pollyannish crystal ball at a potential cornucopia of food and fiber, which may burst forth from our agricultural research establishments, can no doubt pass many pleasant hours reading this book. Those seeking solutions to world hunger and the maldistribution of food, even within our domestic environs, should probably look elsewhere. Those in search of tractable research topics in the areas of structure, finance, and trade policy should be stimulated by last two sections of this book, which I recommend to them.

Prospects for Soviet Grain Production

Brigitta Young. Boulder, Colo.: Westview Press, 1984, 216 pp., $20 (paper).

Reviewed by Jim Cole*

In *Prospects for Soviet Grain Production*, Brigitta Young, a graduate student at the University of Wisconsin, has produced a primer on agricultural problems that have persisted in the Soviet Union since the Revolution. As such, the title is somewhat misleading.

The book begins with an interesting and informative three chapters. The first details long-term geographical and geological problems that have plagued Soviet planners. It includes subsections on land use, weather conditions, and soil types. But the technical degree of the material presented in these chapters is probably too high for most readers. Furthermore, information which is merely reproduced here is readily available and probably already sitting on most Soviet researchers' bookshelves. Throughout this section, Young uses Paul Lydolph's *Geography of the USSR: Topical Analysis* and the *USSR Agricultural Atlas* published by the Central Intelligence Agency (CIA) in 1974. One citation which would prove to be a useful reference is Nyle Brady's *The Nature and Properties of Soils*, which contains everything you ever wanted to know about soils in the Soviet Union and the world.

The second chapter, "Statistical Problems," is surprisingly short. Although noting that some agricultural data are missing from long-term series, the text fails to mention that since 1981 the Soviets have not provided grain production or yield data, which they agreed to do when they signed the U.S.-USSR Agriculture Agreement. Thus, some years that might prove the most interesting of all have been omitted from Young's analysis. Other data, as Young points out (Soviet grain stocks data, for example), have never been published.

The most valuable and interesting portion of the book is the third chapter which puts the grain production problem into perspective. Whereas D. Gale Johnson and Karen McConnell Brooks in *Prospects for Soviet Agriculture in the 1980s* (see *Agricultural Economics Research*, Winter 1984, Vol. 36, No. 1, pp. 23-24) considered Soviet agriculture from the fifties to the present, Young presents information about the history of Soviet agriculture from the post-Revolutionary period to the present with some interesting grain trade data from the early 20th century.

In an attempt to assess the impact of external forces on Soviet agricultural performance, Young devotes a chapter of her book to a "Critique of Recent Western Analyses of Soviet Grain Shortfalls." This critique, however, is limited to a discussion of the author's dissatisfaction with the CIA grain production model and a "computer" model that she and colleague Jill Auburn put together to test the impact of weather on grain production and to test if the marginal returns to grain production regarding technological inputs (in particular, fertilizer) are diminishing. Young does not discuss U.S. Department of Agriculture methodologies currently used by the Economic Research Service, the Foreign Agricultural Service, and the World Agricultural Outlook Board.

Young and Auburn encountered problems with the model from the start. Weather data (temperature and precipitation) were gathered from only one weather station per region; Kiev, for example, was the surrogate for "Southern European USSR and the Ukraine." Furthermore, after unsuccessful attempts to solve multicollinearity problems (using fertilizer use and tractors as separate variables), Young and Auburn used fertilizer use alone to represent technological development. Even so, they were able to explain only half the variation in yields. Young concludes that the model was unable to substantiate either the claim that weather is the chief limiting determinant of Soviet grain production or the idea that marginal returns for agricultural inputs in the USSR are diminishing. That is the difficulty of using statistical models to estimate Soviet grain production.

Prospects for Soviet Grain Production tends to preach as it informs, and relies heavily on existing publications. Only in rare instances are any Russian-language sources noted, and in those cases they are used for data only—not concepts. Considering the expensive price tag on the book, I expected more.

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Closing the Cereals Gap with Trade and Food Aid

Barbara Huddleston, Research Report No. 43, International Food Policy Research Institute, Washington, D.C., 1984, 107 pp., free upon request.

Reviewed by Mathew Shane*

Barbara Huddleston's report which focuses on developing the magnitude of food aid and trade with developing countries both historically and to 1990 is an important effort on an important subject. It should be put on the "must" reading list for anyone interested in questions relating to food aid. Although it is a research publication intended primarily for other agricultural economists in the food aid and development assistance areas, the implications of the analysis are extremely important for policymakers as well. Being an ambitious effort, it has both the strengths and weaknesses of such efforts.

On the positive side, the author develops and presents the first consistent series on world food aid and trade in cereals over a 20-year period, 1961-81. The trends, composition, growth rates, and import dependence ratios are thoroughly presented and analyzed based on major geographic regions—Asia, Latin America, North Africa/Middle East, and Sub-Saharan Africa—as well as high-, middle-, and low-income developing countries. Huddleston includes data on 99 countries in her study.

Some of her conclusions merit serious consideration by policymakers in donor countries:

- For all income groups and for all regions except for Sub-Saharan Africa, food aid per capita declined after the early sixties....[F]ood aid per capita in low-income countries is now less than half of what it was 20 years ago, and...total imports of cereals per capita declined for this group alone (p. 25).

- Although most countries want to provide enough food to eliminate hunger and malnutrition, not all have equal success in doing so. [Indeed in] 1977-79 average per capita intake... was less than 90 percent...of the FAO/WHO standard...[in 28 countries] (pp. 35-36).

- ...27 countries had seriously inadequate per capita food supplies in 1977-78. For 14 of them current consumption is less than it was in 1961-63 (p. 38).

- Of countries with adequate food supplies, 21 received food aid and 14 did not. Those receiving food aid accounted for 38 percent of total food aid at that time. Two of them, Egypt and the Republic of Korea, took 30 of that 38 percent (p. 38).

- If the mean for per capita food aid had been higher for low-income countries with inadequate food availabilities and lower for middle- and high-income countries with adequate food availabilities, the seriousness of the food supply problem could have been reduced even with no increase in food aid. It does appear, however, that on the whole, large quantities of food aid are flowing to countries that need it, though in insufficient amounts (p. 40).

The results support the conclusion, which is emerging from global hunger studies, that the world is divided into countries that are successful at development and those that are not. Those that have developed an economic base over the past 20 years can look forward to vigorous growth and trade, whereas those that have not will face increasingly serious difficulties. For the policymakers involved with development prospects in the third world, one must be concerned with how we can define food aid and development assistance programs which encourage the less successful developing countries to get into a long-term self-sustaining development path rather than become long-term welfare recipients. The factual background presented in this report provides a foundation upon which such program decisions can be made.

These are the strong points of the report, and Huddleston and the International Food Policy Research Institute (IFPRI) should be commended on the analysis. However, some problems also flow from a report with multiple objectives. Much of it is

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devoted to the problems with and resolutions of issues related to data derivations and procedures. Although these issues are important for professionals, indeed ERS' own efforts on *Food Aid Needs and Availability* are of this sort, some reorganization of the material might have made Huddleston's research more useful to a broader audience.

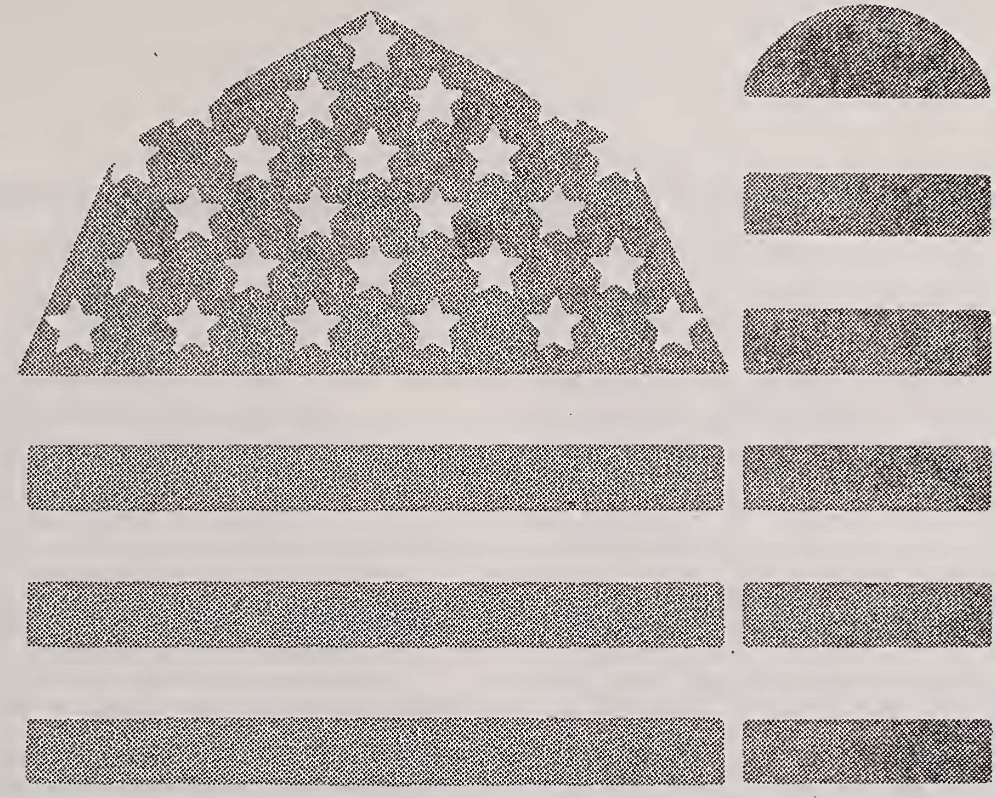
Another issue of fundamental importance that she does not seriously address is why some countries end up requiring food aid and others do not. What distinguishes successful countries from unsuccessful ones? Until we can answer these questions, all our aid efforts will remain somewhat of a shot in the dark.

I look forward to the further studies which should develop out of this one at IFPRI, and I appreciate its depth and perspective.

In Earlier Issues

Increased specialization of production tends to decrease the elasticity of supply because equipment and skills tend to become highly specialized and less mobile. Other things equal, the greater the specialization, the more unstable the returns. The relevant price spreads become narrower and given percentage changes in price for commodities bought and sold can cause a larger percentage change in returns.

Allen B. Paul
Vol. 26, No. 2, April 1974



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